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FULLY PROCEDURALIZED JOB PERFORMANCE AIDS:
GUIDANCE FOR PERFORMING BEHAVIORAL ANALYSES OF TASKS

Edgar L. Shriver

URS/Matrix Research Company

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By

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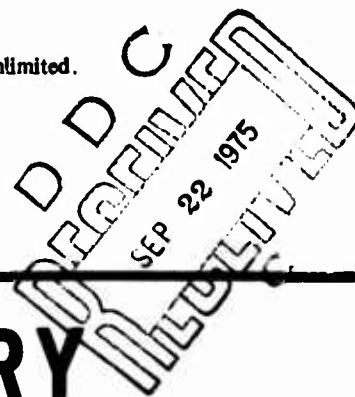June 1975
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This technical report has been reviewed and is approved.

GORDON A. ECKSTRAND, Director
Advanced Systems Division

Approved for publication.

HAROLD E. FISCHER, Colonel, USAF
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The initial tryout of FPJPA, for the UH-1H helicopter, indicated that although they met all the format requirements for FPJPA, they did not produce the expected level of task performance when used by novice and apprentice Air Force maintenance personnel. The author hypothesized that the FPJPA did not contain all of the cues and directions necessary for the novice and apprentice personnel. In this report he describes a method for identifying such cues and responses during a "hands on" tryout of the initially produced task steps. He calls this method the behavioral analyses of tasks (BAT). The application of this BAT to many tasks produced an "unfolding" effect from pictorial to pictorial. It also identified many important but unplanned cues in the troubleshooting routines. Its application to the eleven UH-1H tasks used for the evaluation raised the performance level of both

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novice and apprentice personnel. FPJPA of reasonable effectiveness will probably be developed with less rigorous "hands on" analyses of tasks than the BAT proposed in this report; provided, the FPJPA so developed are followed by a "cut and try" process of improvement. The accomplishment of a BAT requires highly skilled and tedious work on the part of each task analyst and its use will probably be viewed by some as too expensive. But the author's experience indicates that its timely use in the FPJPA development cycle will be necessary for the consistent production of a quality product at a minimum cost.

SUMMARY

Problem

As a part of the Vietnamization program, three types of job perform-
and aids (JPA) were developed to support organizational (flight line)
maintenance of the UH-1H helicopter by personnel of the Vietnamese Air
Force (VNAF). These JPA included fully proceduralized JPA (FPJPA) for
non-troubleshooting tasks called job guide manuals, FPJPA for troubles-
shooting tasks and troubleshooting JPA based on maintenance dependency
charts (MDC). An evaluation of these JPA was conducted to guide the
development and use of future JPA for the VNAF and the United States Air
Force (USAF). During initial tryout of the FPJPA for both troubleshoot-
ing and non-troubleshooting tasks, all of the technical errors were
corrected in the FPJPA. When the controlled evaluation was started, it
was discovered that the performance of novice, apprentice and experienced
USAF maintenance personnel was no better with the FPJPA than with the
conventional technical manuals, a result which was not anticipated based
upon previously available data.

Approach

After extensive observation of several subjects' performance of tasks
using the FPJPA, the author, the technical director of the evaluation,
concluded that the FPJPA met all the format requirements of FPJPA specific-
ation. The printed instructions were in the proper step-by-step format,
each step was written in the required standard language, and the step-by-
instructions were supported by location pictorials. He hypothesized that
the written directions and their accompanying pictorials did not contain
all of the cues and directions necessary for novice and apprentice person-
nel to successfully perform the tasks. The directions for each task were
analyzed in terms of the cue and response chains required to perform the
task. The missing cues and directions for missing responses were added
to the FPJPA. This process is called the behavioral analysis of tasks
(BAT) in this report. The BAT was applied to the FPJPA directions for the
11 tasks selected for evaluation.

Findings

After the FPJPA had been modified to include the additional cues and
directions called for by the BAT, the performance of both the novice and
apprentice greatly improved when using the FPJPA. For example, the appren-
tice personnel performed 95 percent of their assigned tasks. This was
equivalent to the performance of the experienced personnel. The applica-
tion of the BAT to many tasks produced an "unfolding" effect from
pictorial to pictorial. It, also, identified many important, unplanned
cues in the troubleshooting routines.

Conclusions

The consistent production of optimumly effective FPJPA will probably require the application of BAT procedures similar to those described in this report. FPJPA of reasonable effectiveness will probably be developed with less rigorous "hands on" analyses of tasks than the BAT proposed in this report provided the FPJPA so developed are followed by a "cut and try" process of improvement. The accomplishment of a BAT requires highly skilled and tedious work on the part of each task analyst, and its use will probably be viewed by some as too expensive. But the author's experience indicates that its timely use in the FPJPA development cycle will help produce a quality product at a minimum cost.

PREFACE

This report presents a bi-product of an evaluation of the job
performance aids developed for the UH-1H helicopter as part of the
Vietnamization program. The aids represent an expansion of job performance
aids technology developed by the Air Force Human Resources Laboratory
under Project 1710, Training for Advanced Systems, and by the AFSC Space
and Missile System Organization under project PIMO (Presentation of
Information for Maintenance and Operations). The report covers a part of
the research done by URS/Matrix Research Company under Contract F33615-
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Dr. Edgar L. Shriver of Matrix Research Company was the principal investi-
gator and project director.

The preparation of this report has been documented under Task 171004,
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Training for Advanced Air Force Systems. Work reported in this document was
accomplished under work units 11271301 and 17100425. Dr. John P. Foley was
task scientist and contract monitor. Dr. Ross L. Morgan was project
scientist. LtCol Jack Bond was project monitor for the Aeronautical Systems
Division.

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FULLY PROCEDURALIZED JOB PERFORMANCE AIDS: GUIDANCE FOR PERFORMING BEHAVIORAL ANALYSES OF TASKS

I. TASK IDENTIFICATION AND IN-DEPTH ANALYSES OF IDENTIFIED TASKS

The materials presented in this report were developed as a by-product of an evaluation of job performance aids (JPA) produced for the UH-1H helicopter. These materials are presented as a separate report because they contain an important message which is worthy of more widespread distribution than normally given such an evaluation report. The message, however, is subtle. It involves the "fine tuning" of the directions, both written and graphic, that are placed in fully proceduralized job performance aids (FPJPA). The message is that the step-by-step directions and accompanying graphics may be technically correct from the point of view of engineers, traditional technical writers, and experienced maintenance technicians and may meet all the restraints of simple standardized language normally attributed to the FPJPA technology, but still not contain all of the necessary cues and directions for a person who is not completely familiar with the equipment being maintained. The report also describes a method for achieving this necessary "fine tuning." However, it is not intended to provide sufficient guidance for a technical writer to become a behavioral analyst with adequate ability to achieve this "fine tuning." Most people will require a large amount of supervised practice to acquire the necessary skill for this "fine tuning" process.

A second motivation for this report was that the Air Force Human Resources Laboratory (AFHRL) draft specification and guidance documents do not provide for or guarantee this fine tuning. The AFHRL specification and guidance documents referenced in this report are presented in a three volume report AFHRL-TR-71-53 (Folley et al., 1971a; 1971b; Joyce et al., 1971). There is a more recent version of this three-volume report AFHRL-TR-73-53 (Joyce et al., 1973a, 1973b, 1973c). (The earlier documents are referenced here, since the structure and names of subproduces of those documents match those used in this report.) Both AFHRL-TR-71-53 and AFHRL-TR-73-43 represent Americanizations of the Vietnamization Specification MIL-J-83302 and its guidance documents (Applied Science Associates, 1970, 1971a, 1971b). The products called for by these documents require two levels of analysis: (1) task identification or job analysis, and (2) the analysis of each identified task. Many people think that they have completed a task analysis when all they have completed is the task identification (Foley, 1973). The task identification matrix (TIM) found in AFHRL-TR-71-53(I) provides a structure for this necessary task identification step. The analysis of tasks identified by the TIM is called for in the development of The Task Description Index and Management Matrix (TDIMM).

This TDIMM requires the consideration of many necessary items of analysis. Column K of this TDIMM requires a listing of the task steps. But in the opinion of the author, neither the specification nor the guidance documents gives sufficient consideration as to how these task steps are to be optimized for maximum effectiveness. The task steps, listed in column K, could come from several sources such as an "arm chair" development by a technical writer, an interview with an experienced maintenance technician, or an already published technical order or manual. Any of these sources would fulfill the requirement of the specification. However, some people who have developed FPJPA are convinced that such task steps and accompanying graphics should be given a "hands on" tryout on actual equipment before they are finalized in the TDIMM. One contractor has called this process a "hands on" task analysis. The author proposes a more highly refined "hands on" analysis than is normally given task steps; as analysis, that would surface most of the important environmental cues that would normally be missed by a conventional "hands on" analysis, cues that are necessary for highly effective FPJPA. He has called this type of "hands on" analysis, behavioral analysis of tasks (BAT). The list of task steps required in column K is the first step or starting point for the BAT.

II. TDIMM: THE STARTING POINT AND SUMMARY END POINT FOR THE BEHAVIORAL ANALYSES OF TASKS

The TDIMM is a management document which represents the contractor project manager's current status on all identified tasks that fall under this responsibility. The manager will use it as a tool for monitoring the results of the BAT. It serves as the criterion of input and output conditions for each task.

The steps in the BAT are not recorded in the TDIMM, but the specification for column "K" does apply to the BAT that is performed in accomplishing the objective set out in column "K." As each task is subjected to a BAT, the TDIMM should be corrected to correspond to requirements identified during the BAT. The accomplishment of the BAT may uncover the need for correction to the data entries in other columns for that task. For instance, as the detailed steps are identified and documented, it may be found that more or fewer personnel are required to accomplish the task. If the manager finds this number to be valid, it is then changed in columns F1, F2, and K6 of the TDIMM. Also, it may be found that certain special tools are required that were not entered in column "D" of the TDIMM; likewise with notes and cautions for column "H," etc.

The TDIMM should be prepared by managers and senior personnel. It requires a broad knowledge of documentation and authoritative sources, which managers and more experienced personnel are more likely to know about. The manager must take direct responsibility for initially setting conditions, as well as for changing them when they are found to be incorrect. The manager

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will change any column entry in the TDIMM when he determines that an exception, called to his attention by a task analyst who is performing a BAT, is valid. He may have to consult other authoritative sources to make these determinations. The TDIMM is then official in its updated form which incorporates the results of the BAT. (Throughout the discussion that follows the author has assumed that the intended users of the FPJPA will have had little or no previous hands-on training. This was the assumption made in the first set of FPJPA guidance documents (AFHRL-TR-71-53). The later AFHRL-TR-73-43 provides for consideration of the training/FPJPA trade-off. This is sometimes called the head/book trade-off. In some cases, such consideration may reduce the number of cues required in the FPJPA. However, the BAT requirement still exists to insure that the FPJPA contains all of the necessary cues for the described intended users.)

III.   WHAT THE ANALYST DOES IN MAKING A BAT

1.   BAT Format. The principal column headings on the BAT format are CUE and RESPONSE. The CUE refers to what the man sees (or hears, smells, etc.). The RESPONSE refers to what he does, reads, sees (as including hears, smells, feels). The BAT form must be filled in with CUE and RESPONSE and certain other information. Appendix A provides an example of a BAT for the removal of a jeep carburetor in the proposed BAT format.

2.   How to Identify Cues and Response. The CUE entries in the column are what the maintenance man sees. The initial CUE almost always is the aircraft sitting on the flight line with an access panel highlighted. The maintenance man's response to that cue is to go to that access panel. This is entered in the RESPONSE column.

The next general response which the maintenance man is going to make is to "open the access panel." But the analyst first must think of the cue that can initiate that response. He finds that there is no overall cue for that response. What the maintenance man sees is an access panel. What should be highlighted as the next cue for him to respond to? The screws holding the panel in place are the answer. What is the response to these screws? He should pick up a screwdriver and turn them one-half turn counterwise. This should go in the RESPONSE column on the same row with the highlighted screws. Now the analyst asks if the maintenance man can open the panel. He finds that there is a handle which must be turned. This is the next CUE entry to highlight on the panel, and the response is to grasp the handle and lift up. (The response might be to pull to the left or something else, depending on the mechanics of the panel.) If the response is anything but the simplest action, an additional cue must be sought by the analyst and recorded. The cue column must have sufficient detail for an artist or photographer to produce a picture which the maintenance man can compare to the real equipment and identify. This series of cue

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and response entries details the general response of "open door." Whereas, the traditional technical order or handbook would be largely verbal and written in terms of responses like "open door," this type of analysis breaks out a general response into details and identifies *cues,* as well as responses. It requires both cues and responses for an effective FPJPA. The maintenance man must be able to perform all steps in maintenance with no other aid than the fully proceduralized one.

After the access panel is opened, the cue becomes a picture of what is inside the panel. If the terminal item is not accessible at this point, the behavioral task analyst must make further entries in the BAT form. For instance, the carburator may be in front of the terminal unit. The general response would then be "remove carburator." But the analyst would have to identify the cue of "carburator" for highlighting in a picture. Then the bolts and safety wiring would have to be identified and shown. The tools the maintenance man uses are called out in another column. The analyst may have to produce an analysis for the use of these tools, spelling out cues and responses.

The next cue would be the interior of the access chamber with the carburator removed. Then, if the terminal item is still not accessible for the type of maintenance required, additional items must be removed.

3. <u>Level of Detail</u>. The BAT has no inherent level of detail. When it is used for the development of FPJPA, the implied level of detail is very fine. It is being used to support job performance *fully*. The man using it is supported without other training or information sources. This means the level of detail in the BAT must provide full information on everything the man should *see* and *do* in the maintenance which is covered in the FPJPA.

The process of analyzing in cue and response terms in the BAT tends to keep the analyst at a specific level of detail. In the process of asking himself what the cue for a response is, he forces himself to specify very specific elements, and this, in turn, helps him to break down some responses which he might initially have wanted to enter on the form.

4. <u>Subdivisions of CUE</u>. It was said previously that the primary information in BAT is "CUE," and "RESPONSE." The CUE specification also contains a "context" and "focus." These always change after the accomplishment of a response step. The completion of each response always sets up a new "cue" situation which keys the next response.

5. <u>How Purpose Structures CUES and RESPONSES</u>. What the maintenance man *should* see is an important point. The task analyst selects and focuses him on what he *should* see. What he *should see* is function of what he *should do* next. If he is to open an access door, he should see *that* door

closed. And the way to identify *that* door is to give him a larger field
of view (or context), to provide an indication of where that door is in
relation to other doors. For instance, a view of a helicopter with the
right access door highlighted (general location, shaded pointing arrow,
etc.) would provide both the context and focus of what the maintenance
man *should* see if he is to respond with opening that door.

6. How Access CUE (context and focus) and Response are Related.
Once the response of opening the door is made adequately, the context and
focus are now changed. The context is whatever is behind the door. The
focus is determined by considering what the man must do next. What he can
do next is limited by what he can see now. He cannot remove a part that is
not in view. The next line of the BAT format must be concerned with a res-
ponse which will change the view so that the terminal response can finally
be made. If the carburator must be removed in order for the maintenance
man to gain access to the part behind it, then the response prescribed in
the BAT is to remove the carburator and the focus of the interior view is
the carburator.

The analyst must decide whether or not additional lines of cues and
responses must be allocated to the steps in removing a carburator. To
accomplish a fully proceduralized job, the next response would be to remove
mounting screws. For this response to be made, the focus of the maintenance
man is the screws.

7. Each Step Must "Pick Up" Where the Previous Step "Left Off. The
context view for this focus must be one that picks up where the previous
focus left off. For instance, if the highlighted carburator in the field
of an open acess door was the previous focus, then the field of the diagram,
or picture, showing the next focus (mounting screws) must be the carburator
in a relationship to the previous focus. Words can be used to aid in this
"pick up." For instance, if the maintenance man must put his head inside
and look up to see the mounting screws, it is appropriate to enter this
information on the BAT format. Then if he must feel for the screws, with-
out being able to get head and hands inside at the same time, this infor-
mation should also be entered on the BAT format. If dropping a screw
from this position would create a serious problem, this should also be noted
on th BAT format. The BAT format is completed in this way.

8. Control of Graphics. When the BAT is completed in first draft form
for a particular identified task, it should contain sufficient information
for the graphics and editing department to create the appropriate task
descriptions. After combination with graphics information, another technical
writer, responsible for quality control, should be able to go through the
entire task on the equipment without having any errors or quest'ons about
how to accomplish the task.

Accomplishing the BAT is an interactive process. This interaction is between cues and responses. Graphics and narrative are used together to represent this to the maintenance man.

When the task analyst identifies the cues and responses in a BAT he must insure that this information is adequately prepared in graphic and written form to communicate to the maintenance man on the job. Therefore he must have direct contact with the graphics specialists who prepare the graphic information. The task analyst must "sign for" the graphic information which supports each step of the tasks for which he is performing the BAT. When he signs the graphics documentation, he is certifying that the information in the graphic plus the information in his narrative satisfy both the cue (view and focus) and response information he has determined to be essential in his BAT. The reference to this graphic information is recorded in the manager's TDIMM.

Every step in the narrative (column K2) must have the cue and response information identified for that step in the BAT. Some of this information is in the pictorial that goes along with this narrative description. For instance, the narrative would say "remove five bolts from the base of the carburator." The cue information for the location of those five bolts will be on the pictorial diagram. Each of the five bolts must have the number of the step which refers to the bolts. This is cue identification. If, during the BAT, the analyst has noted that one or more of the bolts are relatively inaccessible, he will have called for a "context" and "focus" pictorial which provides sufficient cue information to the maintenance man for finding the bolts.

9. Treating Consequences of Actions. Further, if the analyst has found in the BAT that accomplishment of the action is removing the bolts can or will lead to further consequences, this information must precede the removal step. For instance, if the carburator can, or will, fall out of position on removal of the bolts fastening it, this information must precede the step describing removal of the bolts. Other consequences would involve spring loaded components, or fasteners, which "fly apart" when unfastened, gear trains that come uncoupled with the removal of an integral element, lower halves of components that fall in the dirt on removal of a bolt on the top half of the component, etc.

Such consequences are treated in one of two ways: (1) a previous note, or (2) a previous step which informs the maintenance man of the cue and response action he must take before completing the next step. For instance, the preceding step might be, "Place hand underneath fuel filter, before finishing the next step, to prevent it from falling when unfastened." If the consequences are more serious, a note such as the following should be needed. NOTE: If bolt X is dropped after removal, it will fall in the magnetron casing and require two hours to retrieve.

NOTE: It should be noted that most existing documentation does not
include such notes when the consequences are not potentially hazardous to
personnel or equipment. The behavioral analysis will often be the only
source of information on these consequences. They should be treated as
previous steps (or notes) whenever possible, when the consequences are more
serious, although short of hazardous.

The BAT is the basis for preparing pictorials and narrative steps.
The pictorial and narrative information must be considered *together* and be
prepared together. Most of the cue information is in the graphics. The
graphic is representative of what the maintenance man will see on the
real equipment when he must perform a certain response action.

10. <u>Treating Non-Visual Cues</u>. If the task is to "adjust carburator,"
this will require more steps and cue information than does "remove carbura-
tor." In this case, the analyst asks himself the same questions about cue
and response. The first question might be, "What do I look for to adjust
carburator?" This might require a special measuring instrument. The
TDIMM would be checked to see if any special tools were prescribed. If
none is listed, other documentation such as the technical manual would be
consulted. If a special instrument were prescribed, the analyst would
bring this to the attention of the manager. Let us say the manager makes
certain inquiries and finds this is not issued to the field and tells the
analyst to make the detailed analysis without it. The analyst may have to
consult some other source, for instance an experienced technician. The
technician tells him that the sound of the engine is important. The
analyst may listen to an engine with a properly adjusted carburator and an
improperly adjusted one, and be able to distinguish between them. He is
then faced with a decision. This *auditory* cue is difficult to describe in
words or in graphics. He discusses this with his manager and if the decision
is to attempt to describe it verbally, the analyst must be careful. The
analyst would describe in words how the engine will sound when the adjust-
ment is going in the wrong direction. It should not be assumed that the
maintenance man will know what the proper sounds are. They must be described
in the step. He must also clearly identify with graphics where the adjust-
ment is on the carburator. Then he writes that the engine speed increases
when this adjustment is turned in the direction of a proper adjustment.
(He cannot indicate that the direction is clockwise or counterclockwise, as
that will depend on the state of the actual equipment). He should consider
a note to the effect that no more than half a turn should be made before
trying the other direction. This would be important if the *consequences*
of turning the adjustment too far in one direction would cause the engine to
fail completely and not start again.

Whenever a visual cue can be used in place of some other kinds, like
auditory, it should be given serious consideration. Visual cues are more
easily defined. But often special test equipment is needed to translate

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something a man cannot see into something he can see. This will involve judgement. The analyst must bring the subject up for decision when he finds a cue that cannot be quantitatively communicated, to see if special equipment can be utilized. Though the decision is not his, he is the one who knows a problem exists, and it is up to him to bring it up to the manager for discussion and decision.

IV. RECURRING OR COMMON SUBTASKS OR SUBROUTINES

Recurring Items of Special Equipment

When BAT is made, it is generally found that certain steps; e.g., unbuttoning access doors, using torque wrenches, setting up test instruments, recur as steps in performing various tasks. BAT will identify such recurrences, but whether the steps involving any one of these recurring items should be included as part of each task analyzed is not answered by the BAT analyst. The decision to treat these recurring items "off line" is an administrative one. The analyst only identifies these recurring situations for his manager and seek decisions on them. The manager should make many of these decisions very early.

But some administrative decisions hould be made by the manager in advance of behavioral maintenance task analysis. Then all analysts must be informed regarding which items have been selected for treatment off line and they must have the correct reference code for them so that they can call them out when they occur in the tasks they are responsible for analyzing.

Examples of items which would commonly be declared as "off line" and given a reference number are screwdrivers, diagonals and other small hand-tools. A torque wrench would often be put in this category as would volt-meters, ohmmeters, pressure guages, and other small test instruments.

Some decisions of this kind may be made only after all tasks are analyzed. In this case, analysts must record each step involving those items each time they occur in tasks. It should be noted that an item such as an oscilloscope may recur in numerous tasks but may be used in different ways in each. Even if a decision is made to treat this instrument "off line" the settings and other specifics of its application should be recorded in the task where it occurs.

The analyst uses the TDIMM form to inform his manager of recurring items. By scanning the TDIMM forms from all analysts under his direction the manager can identify common items across analysts.

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Other Recurring Task Elements

In addition to the recurring items of special equipment which are common to several tasks, there are steps or series of steps that are common to several tasks. For instance, the carburator may have to be removed for the task of servicinḡ the oil filter *and* for removing a fuel pump. In this case, the steps for removing the carburator are identical for both of the tasks. It is inefficient for each analysis to analyze this subroutine of carburator removal *each* time it occurs in a task. It is also inefficient to have the graphics prepared for this subroutine over and over again.

The Access Tree. Therefore, it is necessary to create a "data bank" of such subroutines so that analysts can "draw" on them as needed. This is accomplished through the development of an access tree (AT). The AT is constructed by starting at the first level of each exterior access or inspection provision on the aircraft. Each access item would then branch to the next level of access or inspection panels. This would continue at the lowest level of access required for organizational (flight line) maintenance. At each node in the AT there would be a key to the following:

1. The explicit instructions to gain (i.e., remove five (5) Phillips head screws and swing hinged panel upward).

2. The graphic illustration depicting the access provision.

3. A list of end items that can be acted upon at that point, (serviced, inspected, removed, adjusted, etc.).

The end item could then be cross-referenced on the TDIMM at the AT node. This would permit the analyst to have available the necessary action steps in a subroutine required for access to the terminal object of a task along with the required graphics. This also insures standardization of graphics and prevents duplication of effort.

The manager of the BAT effort will make the decisions on the management of the AT. He must specify how many subroutines will constitute the "initial stock" of the AT. (Subroutines for opening each access door would be an obvious minimum.) Removal of fairings for access to the drive shaft should also be included in the initial stock. If the manager has sufficient familiarity with maintenance and access he could conceivably identify the entire "initial stock" of subroutines. This would represent maximum efficiency, but this is not necessary so long as the manager provides for continuous stocking of the AT as analysts generate access subroutines.

It should be noted that the cues and responses for all access steps will focus on the fastenings of items that must be removed to gain access to what is behind them. That is, in all cases of access the focus of the cues is the fastenings and the responses will involve **unfastening them**. But the context will also be extremely important, especially when the item

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to be removed or its fastenings are in a relatively inaccessible location. The combination of graphics and words used to describe these situations must be sufficient descriptions for the maintenance man.

The index to AT is the obvious one of physical access. Before starting the BAT for any task, the analyst must first check the AT to find how much has already been accomplished that he can use. He then references these subroutines as part of his task and proceeds with the unique, or previously unaccomplished, aspects of his BAT. Any access steps that he analyzes are then sent to the manager for inclusion in the AT stock.

V. SUMMARY

Figure 1 provides a schematic of the job flow of the task analyst as envisioned by the author, including the relationship of his job to the TDIMM, to the FPJPA manager, and to the graphics specialists. These relationships were all discussed in detail previously. Appendices A, B, and C provide examples of the application of the BAT processes to specific tasks.

To perform a BAT, the analyst must mentally put himself in the place of the maintenance technician who will perform the task in the field. After being assigned a task or tasks to analyze, he examines existing documentation (written and graphic). He then goes through the process of performing each step of each task. He continually plays off the question of what can the maintenance man see (cue) and what is he supposed to do (response). After each response the maintenance man will see something new. The analyst must visualize this in his mind and determine whether the graphic he has is adequate to respresent this to the maintenance man in front of the equipment. If not, he formulates what graphic information is needed. He goes through this process for the entire task. He notes when one man does not have the capacity to either see or perform that which must be done to accomplish each step in the task. He indicates how many men are needed and checks this with the TDIMM, discussing differences with his manager.

A step in a task consists of a combination of what a man does and what he can see (cue and response). It is not sufficient to give a step description of "remove carburator." A graphic must be part of this step description. And the graphic must clearly show the location (context) of the carburator and the fasteners (focus) which must be unlossened in order to remove it. Further, the narrative and graphic must be keyed to each other. The accomplishment of any step requires a combination of cue and response information. And this information must be placed in juxtaposition and keyed to one another in such a way that it is sufficient for the maintenance man to see and perform each step on the real equipment from the cue and response documentation.
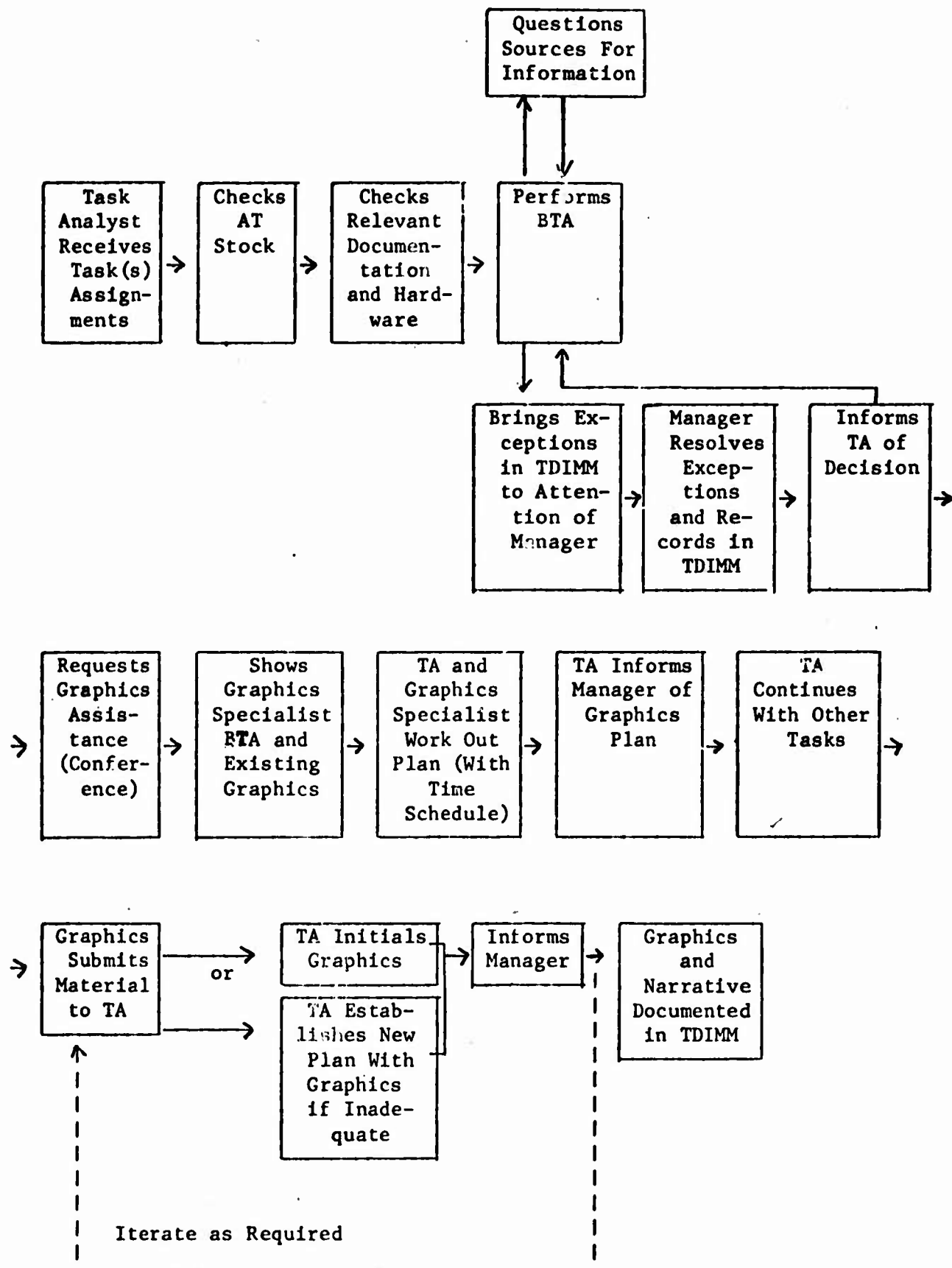
16

Figure 1. Task analysts' job flow.

FPJPA of reasonable quality will probably be developed with less rigorous "hand on" analyses of tasks than the behavioral analyses of tasks (BAT) proposed in this report, provided the FPJPA so developed are followed by a "cut and try" process of improvement. But BAT, such as described in this report, will be required for the consistent production of optimumly effective FPJPA. The accomplishment of a BAT requires highly skilled and tedious work on the part of each task analyst and its use will probably be viewed by some as too expensive. But the author's experience indicates that its timely use in the FPJPA development cycle will help produce a quality product at a minimum cost.

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Joyce, R.P., Folley, J.D., Jr., & Elliott, T.K. *Fully proceduralized job* *performance aids: Volume III - JPA manager's handbook*. AFHRL-TR-71-53(III), AD-744 817. Wright-Patterson AFB, OH.: Advanced Systems Division, Air Force Human Resources Laboratory, December 1971.

Joyce, R.P., Chenzott, A.P., Mulligan, J.F., & Mallory, W.J. *Fully proceduralized job performance aids: Volume I - Draft military specification for organizational and intermediate maintenance.* AFHRL-TR-73-43(I), AD-775 702. Wright-Patterson AFB, OH.: Advanced Systems Division, Air Force Human Resources Laboratory, December 1973. (a)

Joyce, R.P., Chenzott, A.P., Mulligan, J.F., & Mallory, W.J. *Fully proceduralized job performance aids: Volume II - Handbook for JPA developers.* AFHRL-TR-73-43(II), AD-775 705. Wright-Patterson AFB, OH.: Advanced Systems Division, Air Force Human Resources Laboratory, December 1973. (b)

Joyce, R.P., Chenzott, A.P., Mulligan, J.F., & Mallory, W.J. *Fully proceduralized job performance aids: Volume III - Handbook for JPA managers and training specialist.* AFHRL-TR-73-43(III), AD-775 706. Wright-Patterson AFB, OH.: Advanced Systems Division, Air Force Human Resources Laboratory, December 1973. (c)

APPENDIX A: EXAMPLE OF BAT FORMAT
(JEEP CARBURETOR REMOVAL)

This appendix provides an example of a BAT for the removal of a
jeep carburetor using a proposed BAT format. More information and
discussion concerning the thought processes required in making a BAT
are provided in Appendices B and C.

BEHAVIORAL ANALYSIS OF TASKS

WORKSHEET

TEXT		GRAPHICS	
RESPONSE	CUE	CONTEXT	FOCUS
Access			
1. Pull hood latch to left and hold	Hood latch	View of vehicle front	Hood latch
2. Lift hood, then release latch	Hood	View of hood raised, support bar straight	Hood
3. Pull support bar to front	Support bar	View showing support bar in final position	Support bar
Remove Air Cleaner Base			
1. Using blade screw driver loosen lower clamp screw	Clamp screw	View of right side of engine	Inset of clamp screw
2. Loosen clamp	Clamp	View showing clamp loose	Clamp
3. Slide off air cleaner hose	Air cleaner hose	View showing hose removed	Air cleaner hose
Remove Vacuum Line			
1. Using ____ wrench unscrew vacuum line nut	Vacuum line nut	View of right side of engine	Inset of nut
2. Pull out vacuum line	Vacuum line	View showing vacuum line disconnected	Vacuum line
Remove Throttle Linkage			
1. Using ____ wrench unscrew nut	Throttle link nut	View of right side of engine	Inset of nut
2. Pull linkage out	Linkage	View showing linkage disconnected	Linkage

BEHAVIORAL ANALYSIS OF TASKS

WORKSHEET

TEXT		GRAPHICS	
RESPONSE	**CUE**	**CONTEXT**	**FOCUS**

Remove Fuel Line

1. Using ____ wrench unscrew nut Caution on fuel leakage	Fuel line nut	View of engine front	Inset of fuel line nut
2. Pull fuel line away	Fuel line	View showing fuel line removed	Fuel line

Remove Choke Linkage

1. Loosen cable housing clamp nut	Clamp nut	View of left of engine	Inset of nuts
2. Loosen cable clamp nut	Clamp nut	View of left of engine	Same inset
3. Slide linkage out	Linkage	View showing linkage removed	Linkage

Remove Carburetor

1. Unscrew mounting nuts	Nuts	View of right side	Inset of nuts
2. Take off carburetor Note on loosening carburetor	Carburetor	View showing carburetor partially removed	Carburetor

2.6   Remove Carburetor

Applicability: All Models

Tools and Test Equipment: 1.   Blade screwdriver
2.   5/16" open end wrench
3.   7/16" open end wrench
4.   3/8" open end wrench
5.   5/8" open end wrench
6.   L - hammer plastic head

Supplies: None
Personnel: One
Forms: See TM 38-750
Equipment
Condition: 1.   Engine off and cool
2.   Handbrake set

Access

1.   Pull hood latch (1) to the left and hold.
2.   Lift hood (2) and release hood latch.
3.   Lift hood until support bar (3) is straight.
     Pull bar to the front. Hood should be supported with support
     bar in position shown.

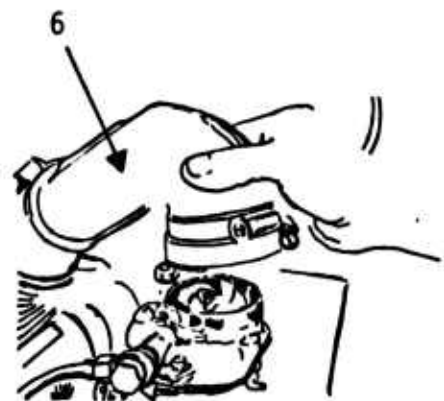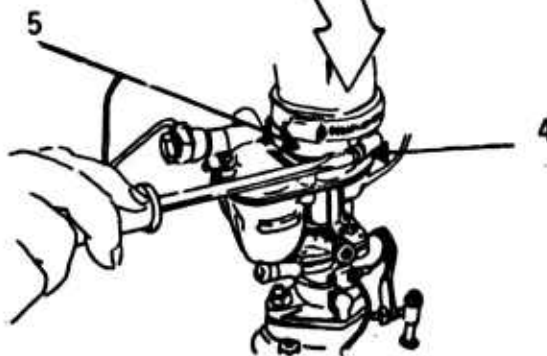## Remove Air Cleaner Hose

4.   Using blade screwdriver, loosen lower clamp screw (4).
5.   Spread clamp (5) until it is loose.
6.   Slide off air cleaner hose (6).
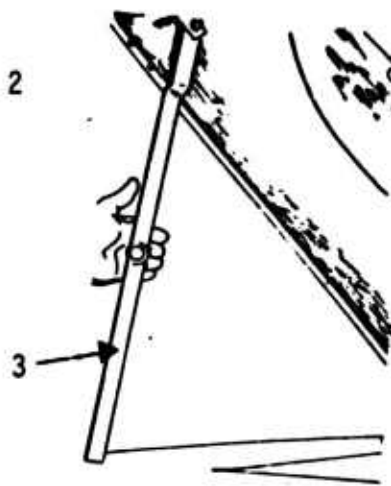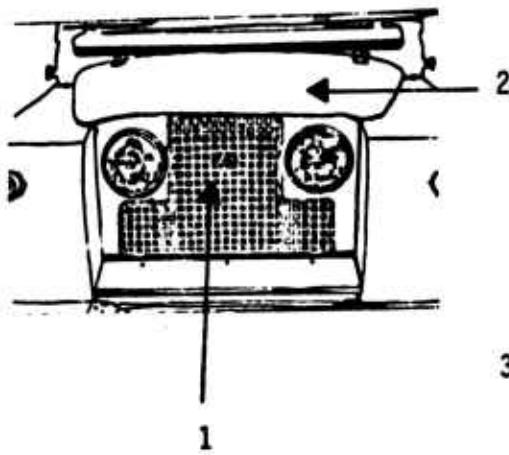
Hood Supported

Engine
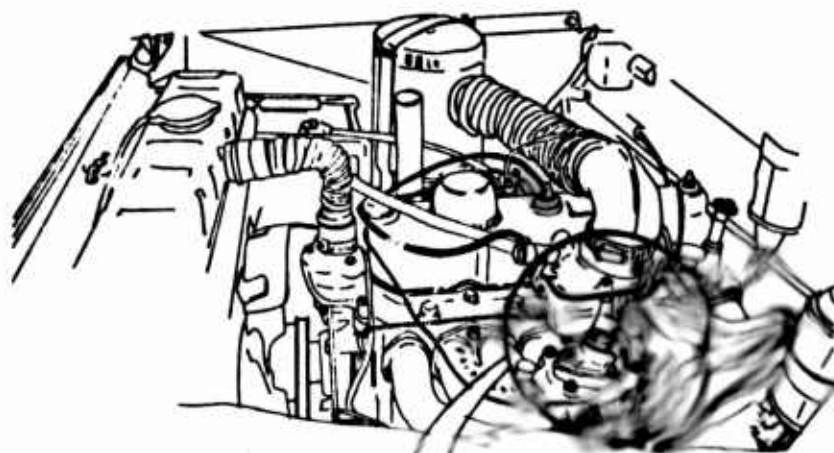Compartment
Right Side

2

1

3

5

4

6
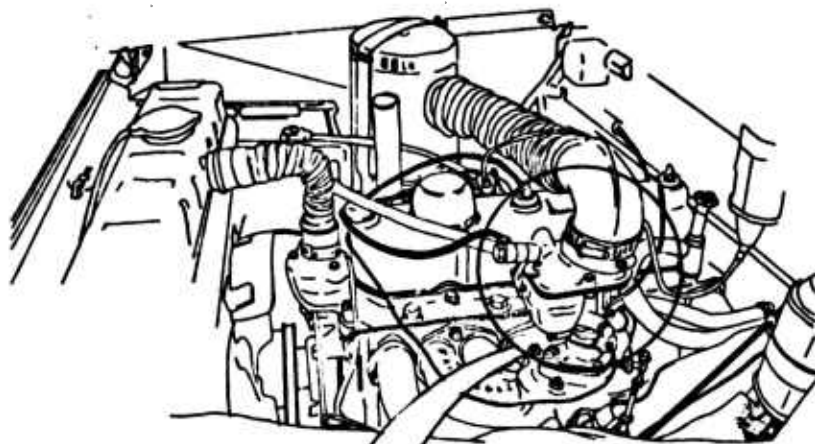
Remove Vacuum Line

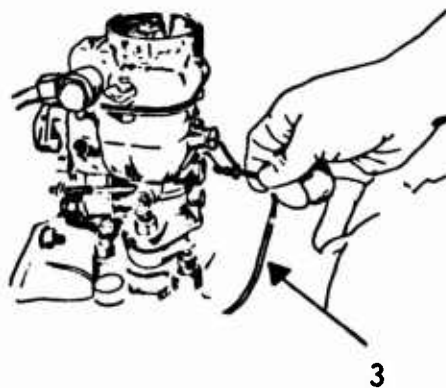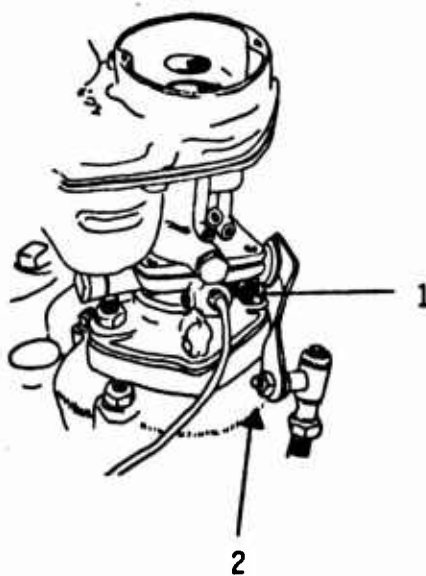   7. Using 5/16" wrench, unscrew vacuum line nut (1).
    8. Pull vacuum line (3) out of carburetor.

Remove Throttle Linkage

    9. Using 7/16" wrench, unscrew throttle link nut (2)
  10. Pull throttle link (4) from carburetor.

Engine
Compartment
Right Side

1

2

3

4

Remove Fuel Line

CAUTION

When fuel line is pulled away, fuel
may leak onto engine. Be sure engine
is cool before removing fuel line.

11. Using 5/8" wrench, unscrew fuel line nut (1).
12. Pull fuel line (2) from carburetor.

Remove Choke Linkage

13. Using 3/8" wrench, loosen cable housing clamp nut (3).
14. Using 3/8" wrench, loosen cable clamp nut (4).
15. Slide cable housing (5) and cable (6) out and away
    from carburetor.
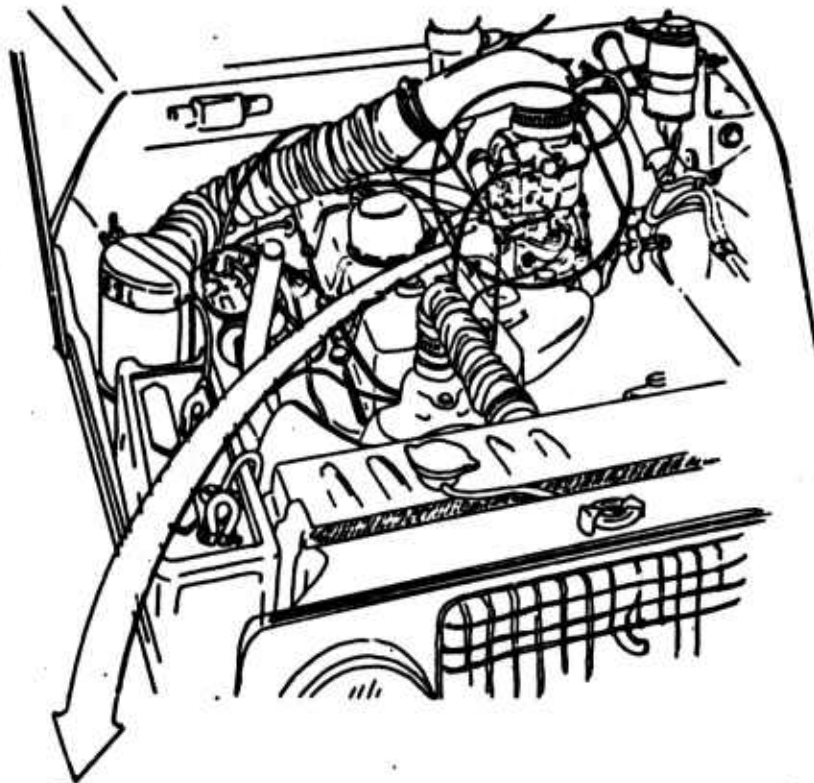
Engine
Compartment
Front View

1

2

3

4

5

6

29
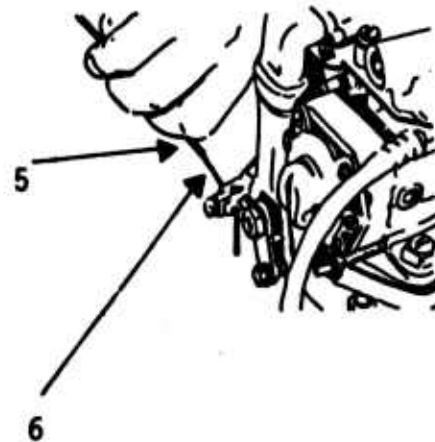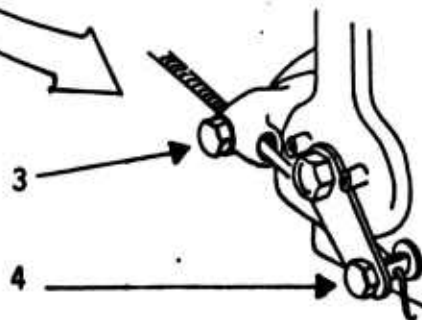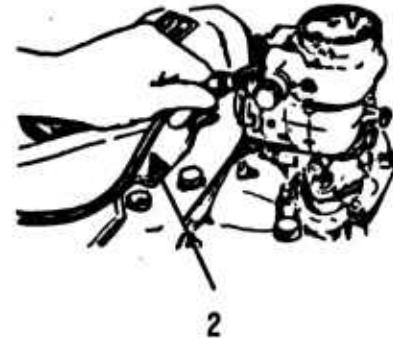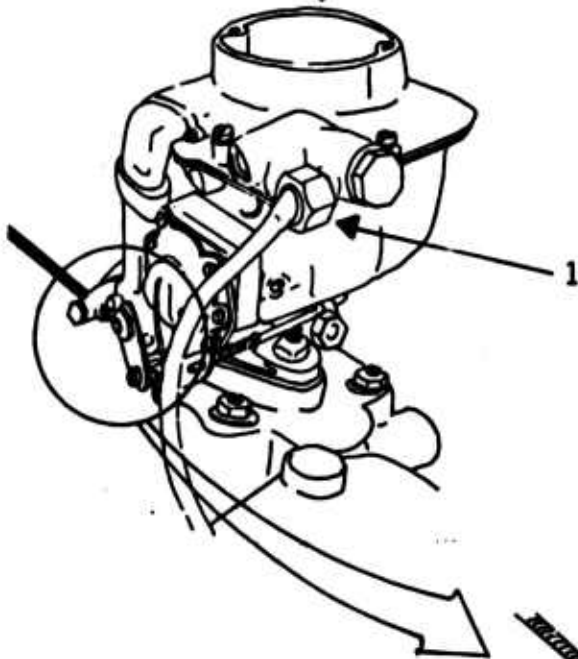
Remove Carburetor

16. Using 5/8" wrench, unscrew mounting nuts (1) to the top of the mounting studs (2).

NOTE

Carburetor may stick to gasket. DO NOT
ATTEMPT TO PRY LOOSE. To loosen tap
carburetor flanges (4, 5) with plastic
headed hammer.

17. Lift carburetor (3), then unscrew and take off mounting nuts.

18. Lift carburetor off of mounting studs (2).
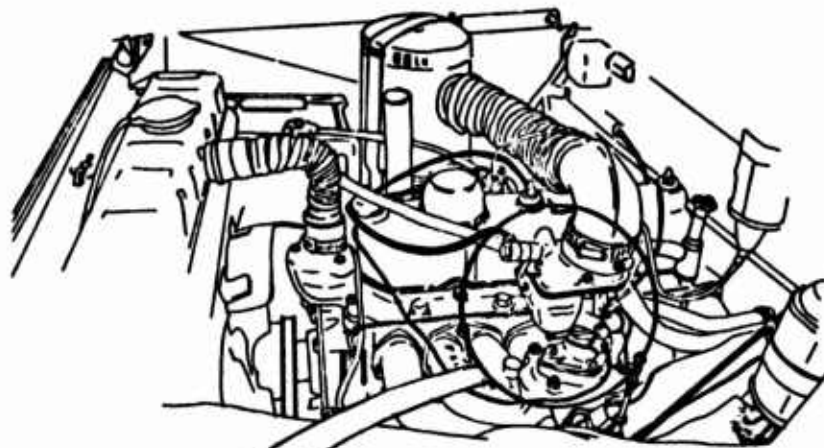
Engine
Compartment
Right Side

Carburetor
Ready for
Removal

31

Available Documentation: T.O.   1F-4C-2-5

      The analyst looks at the graphic and steps of instruction
for removal.

      Step a.   Look at electrical connector and potentiometer. The con-
                 text and focus appear adequate and the verb "disconnect"
                 is on the verb list. The analyst should satisfy himself
                 that no special response such as pinching the connector
                 or giving it a half twist are required. This being done,
                 the step is acceptable as written.

      Step b.   The analyst notes that three actions are included in
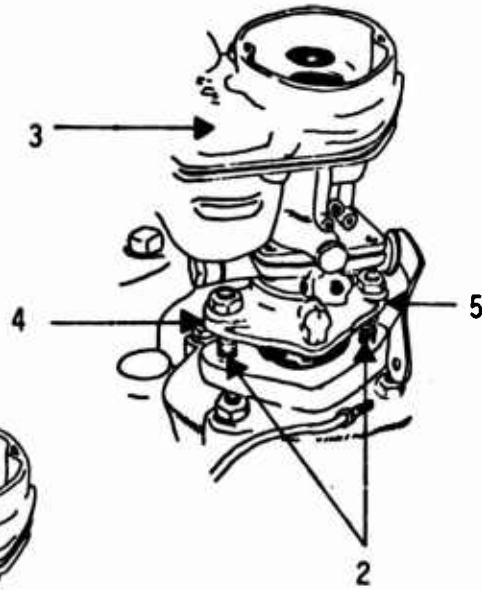   one step. He decides that the three bolts and three
                 washers come out together and should be kept together in
                 one step. But he makes the removal of the retaining ring
                 a separate step. He checks to determine that the retain-
                 ing ring does not require a special response to remove and
                 finding that it just lifts off, he uses the accepted
                 verb "lift" to describe the action in this step.

                 The analyst also notes that three bolts are referred to
                 in the original documentation. On looking for the cue
                 for this on the graphic he sees only one bolt. The holes
                 for two other bolts are shown but the TA asks graphics
                 to put in the other bolts with the appropriate key (2 in
                 this case).

      Step c.   The TA sees that a spring pin is involved in this step.
                 This may mean that there are consequences of this step
                 such as a pin popping out and getting lost
                 The TA explores this possibility and finds that this is
                 not the case, but someone indicates that a spring pin
                 does require a special tool. The TA runs down this poss-
                 ibility and checking the equipment finds that no special
                 tool is required. But he does find that when the spring
                 pin is removed a gear (6) is released and comes out of the
                 potentiometer (7). He asks an experienced technician
                 about this and finds that this should be accomplished
                 with the potentiometer in a vice. Therefore, he sepa-
                 rates this response from the other responses in step (c)
                 and consults with his manager on the possible use of a
                 vice.

He has also found that lifting the potentiometer (7) from
the power unit housing is likely to lift parts (8), (9),
and (10) which will subsequently fall off because they are
only held together with grease. Therefore, the TA puts
the action of catching parts (8), (9) and (10) with one
hand preceeding the action of lifting the potentiometer.

Then as a separate step he puts the action to be taken
if the parts do not come out.

On examination of the wording in step c, the analyst
can see that the awkard wording is consistent with leav-
ing the gear and spring pin in the potentiometer and
removing the other parts. So, though not incorrect, it
is not a good guide.

The TA raises the question of whether removal of the
gear is a shop maintenance responsibility. He checks
the T.O. Index and finds on page 3-50 a chart which says
no higher echelon maintenance is required for this
follow-up potentiometer. He can see that from the T.O.
notes (figure 3-18) that a modification has been made to
the following potentiometer in which this gear is no
longer removable. The problem he is confronted with has
been solved by a change in equipment, but some of the
older equipment is still in the field. So it appears
that replacement of the gear on this older equipment is
the responsibility of flight line maintenance. After a
conference with his manager, the manager indicates that
a vice will be available on the flight line and that the
TA should prepare the steps for removal of the gear with
the potentiometer in a vice.

The TA does this. He finds from an experienced mainte-
nance man that the gear is often damaged in this process
and that the holes should be aligned by sight before
replacing the spring pin. So he prepares the proper
caution and finishes the DTA. He gets the proper graph-
ic and adds the number (11) to key the power unit housing.

The final product looks like the enclosure.

This is recognizably different from the original T.O.

a. Disconnect electrical connector (1) from control unit (4).

b. Remove four attach bolts (2) and washers (3), and remove control unit (4) from aircraft.

3-123. Installation.

a. Install control unit with four attach bolts (2) and washers (3).

b. Connect electrical connector to control unit. (Quality Assurance)

c. Perform operational check. Refer to Paragraph 3-36.

3-124. FOLLOWUP POTENTIOMETER. See Figure 3-18.

3-125. Tools and Equipment.

Torque Wrench   0 to 50 inch-pounds

3-126. Materials.

Lockwire   MS20995NC20
Varnish   TT-V-109
Tape, lacing and tying   Air-Tex #2. NonSlip
dacron, non-slip   Class 2. Cat. No.
treatment (for tem-   50DCF16A (Western
peratures not exceed-   Filament Corpora-
ing 302 degrees   tion) Stur-D-Lace
Farenheit)   #18 DH
Tape, silicone rubber,   Level Wrap LW-40125
self-bonding, black,   T. G. L. Tape
guideline, 0.040 inch   MS70T09-5
thick, 1.00 inch width

3-127. Removal. F-4C, RF-4C-17 63-7740 THRU RF-4C-26 65-901 AND F-4D-24 64-929 THRU F-4D-26 65-611 BEFORE T.O. 1F-4-608.

a. Disconnect electrical connector (1) from potentiometer (7).

b. Remove three bolts (2), washers (3) and retaining ring (4) from potentiometer (7).

c. Remove potentiometer (7) with spring pin (5) and gear (6) attached, packing (8), retainer (9), and gasket (10) from power unit housing.

d. Remove spring pin (5) and gear (6) from potentiometer (7).

e. Remove potentiometer (7) from aircraft.

3-128. Removal. RF-4C-27 65-902 AND UP, AND F-4D-27 65-612 AND UP, ALSO F-4C, RF-4C-17 63-7740 THRU RF-4C-26 65-901 AND F-4D-24 64-929 THRU F-4D-26 65-611 AFTER T.O. 1F-4-608.

a. Remove tying tape and silicone rubber tape.

b. Disconnect electrical connector (1) from potentiometer (7).

c. Remove three bolts (2), washers (3), and retaining ring (4) from potentiometer (7).

d. Remove potentiometer (7) from aircraft.

e. Install a protective cover on followup potentiometer mating surface of power unit to prevent contamination.

3-129. Installation. F-4C, RF-4C-17 63-7740 RF-4C-26 65-901 AND F-4D-24 64-929 THRU F-4D-26 65-611 BEFORE T.O. 1F-4-608.

CAUTION

Be careful when installing new potentiometer to prevent damage to idler gear.

a. Install gear (6) and spring pin (5) on potentiometer (7) and safety with lockwire. (Quality Assurance)

b. Install gasket (10), retaining ring (9), packing (8) and potentiometer (7) on power unit housing.
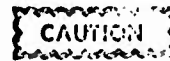
CAUTION

Do not exceed 20 inch-pounds torque when tightening retaining bolts (2). Excess torque will cause bosses on potentiometer gearboxes to crack.

c. Place retaining ring (4) on potentiometer (7) and install on power unit housing with three bolts (2) and washers (3). Torque bolts to 20 inch-pounds. (Quality Assurance)

Note

Potentiometer gearboxes that are cracked in area of retaining bolt bosses are serviceable if not more than one of the three bosses is cracked and boss will resist a 20 inch-pound torque.

d. Connect electrical connector (1) to potentiometer (7).

e. Perform system rigging. Refer to Paragraph 3-115.

3-130. Installation. RF-4C-27 65-902 AND UP, AND F-4D-27 65-612 AND UP, ALSO F-4C, RF-4C-17 63-7740 THRU RF-4C-26 65-901 AND F-4D-24 64-929 THRU F-4D-26 65-611 AFTER T.O. 1F-4-608.

CAUTION

Do not exceed 20 inch-pounds torque when tightening retaining bolts (2). Excess torque will cause bosses on potentiometer gearboxes to crack.

3-38

VIEW A-A

NOTES

1. F-4C, RF-4C-17 63-7740 THRU RF-4C-26 65-901 AND F-4D-24 64-929 THRU F-4D-26 65-611 BEFORE T.O. 1F-4-608.

2. RF-4C-27 65-902 AND UP AND F-4D-27 65-612 AND UP; ALSO F-4C, RF-4C-17 63-7740 THRU RF-4C-26 65-901 AND F-4D-24 64-929 THRU F-4D-26 65-611 AFTER T.O. 1F-4-608.

1. ELECTRICAL CONNECTOR
2. BOLT (3)
3. WASHER (3)
4. RING
5. SPRING PIN
6. GEAR
7. FOLLOWUP POTENTIOMETER
8. PACKING
9. RETAINER
10. GASKET
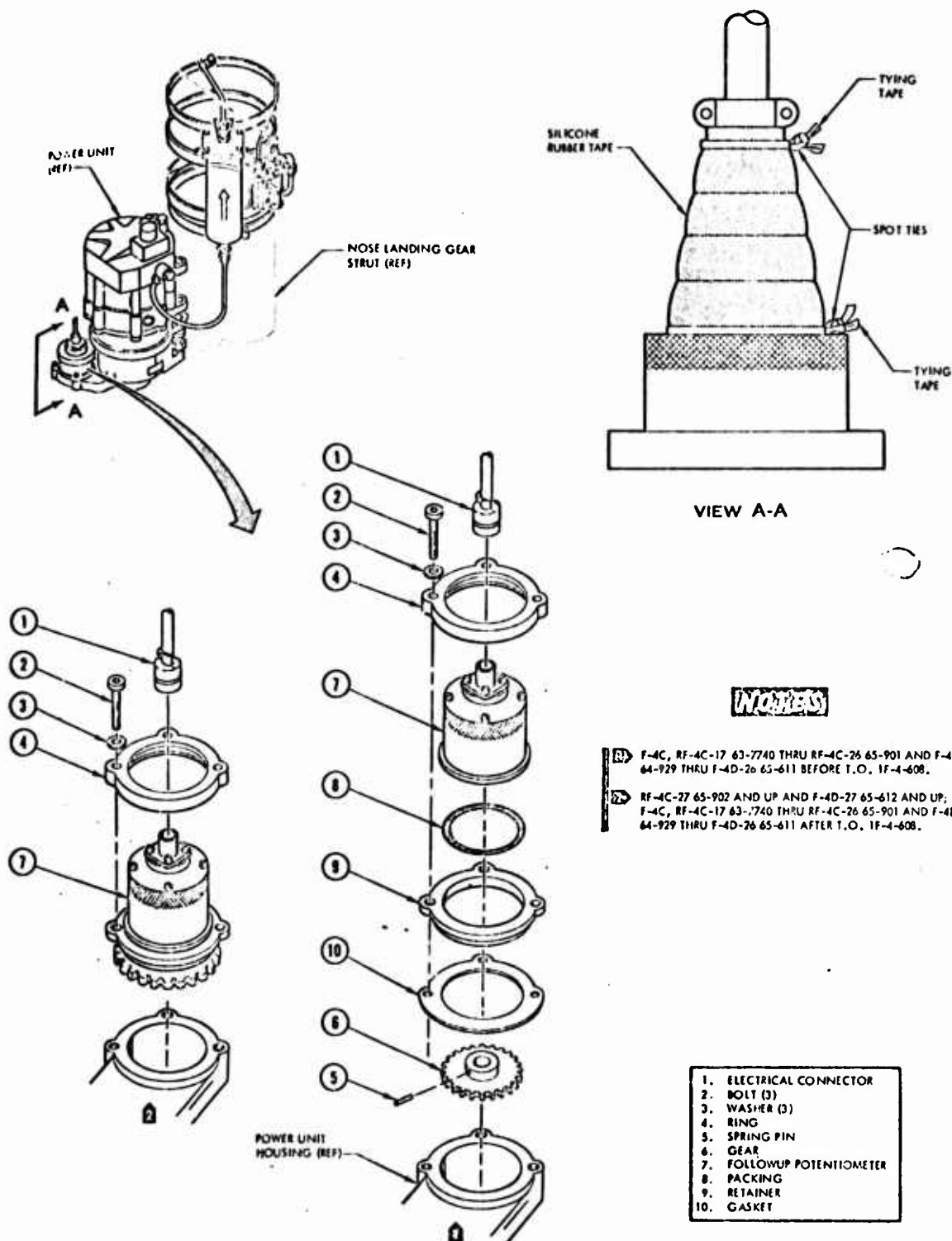
SMH53-14517B

Figure 3-18. Followup Potentiometer Removal and Installation

35

LINE REPLACEABLE UNIT	MANUFACTURER'S PART NUMBER	MAINTENANCE PROCEDURES		
		NONE REQUIRED	CONTAINED IN THIS MANUAL	CONTAINED IN OTHER MANUAL
Compensator	220231-3		X	
Control Box	A05A0004		X	
	A05A0047-1			X
Followup Potentiometer	OMP2202-51	X		
	220262-2	X		
Command Potentiometer	OMP3403-41	X		
Input Potentiometer	220261-1	X		
Power Unit	OMP2202-6,-8			X
*Servo Valve	76154			X
	75030			X
Solenoid Selector Valve	55350-15			X
	2630111-7			X
Filter	AC900-4			X
	11-10185			X
Check Valve	2C5140	X		
Restrictor	2202115-1	X		

*Component of power unit

1. SCREW (4)
2. WASHER (4)
3. END FITTING
4. PACKING
5. SPRING
6. SLEEVE
7. SPRING
8. PIN
9. WASHER
10. SPRING

③

Figure 3-23. Line Replaceable Units

3-193. POWER UNIT.

3-194. Materials.

Barrier material	MIL-B-131
Drycleaning solvent	P-D-680
Hydraulic preservative fluid	MIL-H-6083
Desiccant	MIL-D-3464
Greaseproof Paper	Grade A

3-195. Procedure.

a. Clean exterior of power unit with solvent. Do not saturate the electrical components. Dry with low pressure shop air.
b. Unplug hydraulic ports and flush with hydraulic preservative fluid. Plug all ports.
c. Wrap unit with Grade A greaseproof paper.
d. Cushion with corrugated fiberboard and Type II cellulose wadding and pack in a corrugated carton with five units of desiccant.
e. Seal the carton with barrier material and pack the sealed carton in a second corrugated carton to protect barrier.

3-196. SERVO VALVE.

3-197. Materials.

Drycleaning solvent	P-D-680
Barrier material	MIL-B-131
Desiccant	MIL-D-3464
Greaseproof paper	Grade A

3-198. Procedure.

a. Clean valve with solvent and blow dry with low pressure shop air.
b. Wrap valve with Grade A greaseproof paper.
c. Cushion with cellulose wadding and place in a bag of barrier material with two units of desiccant and seal bag.
d. Place package in corrugated carton.

3-199. CONTROL UNIT.

3-200. Materials.

|	
Drycleaning solvent	P-D-680
Barrier material	MIL-B-131
Desiccant	MIL-D-3464
Plastic wrap	

3-50

NOTES

Power Unit

Nose Landing Gear Strut

REMOVE AND REPLACE FOLLOWUP POTENTIOMETER

1. Disconnect electrical connector (1) from potentiometer (7).

2. Remove three bolts (2) and three washers (3).

3. Lift retaining ring (4) from potentiometer (7).

4. Place one hand around the power unit housing to catch parts (8), (9) and (10) and lift potentiometer (7) from power unit housing (11) with the other hand.

5. If parts (8), (9) and (10) do not come out of place, remove from power unit housing (11).

6. Remove potentiometer (7) with gear (6) attached from aircraft.

CAUTION

Be Careful when removing gear (6) from potentiometer (7) to prevent damage to gear

7. Remove spring pin (5).

37
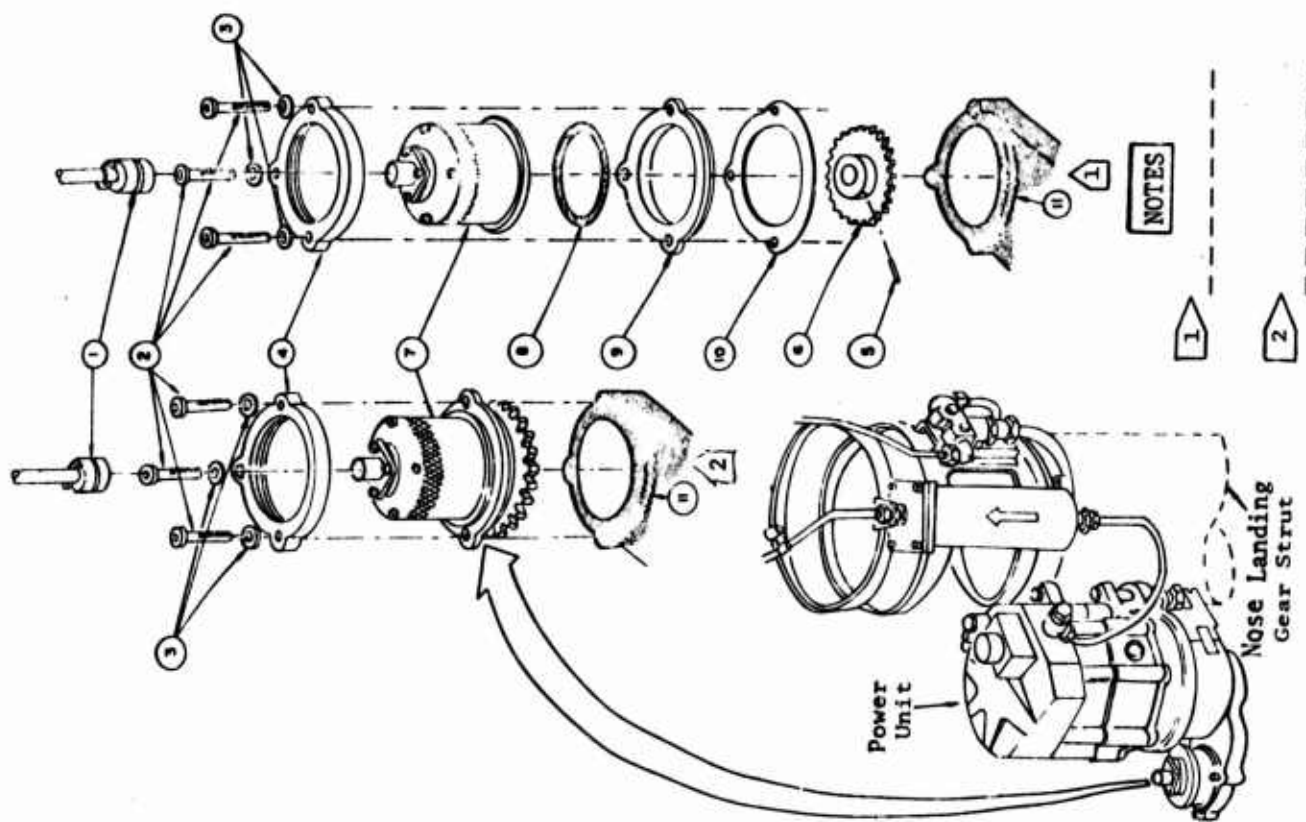
The following is an example of the application of the Behavioral Task Analysis to one particular task.

One test item was the simple Task of Cleaning the Engine oil filter. This should require about 15 minutes to remove one bolt, take out the filter, insert it in a special tool, connect an air hose to the tool and immerse the whole thing while blowing air through the filter inside the special tool.

Subjects were observed to disconnect oil lines and remove the filter housing, and then, without removing the filter from the housing, place the entire assembly in the cleaning solvent, and reinstall it in the equipment. Thus, the equipment was disassembled, two hours had been required to do a 15-minute job, and the filter had not been cleaned.

The Task Analyst inspected the JPA steps and graphics. The technical data elements were all present, and the written steps did not tell the man to remove the oil lines and filter housing! So what was wrong with the JPA? There was nothing obvious; the man had not stopped at any step; in fact he was proceeding steadily in doing the wrong thing. The Task Analyst had to go through the task process thinking at each step what the instructions and illustrations would mean to a novice. The analyst was, at the same time, examining the equipment.

The critical element in Task Analysis appears to be the skill of the analyst in projecting a picture of how the novice will perceive the real equipment and relate to it using the simulation of the real equipment represented in his documentation as a reference. It should be recognized that words, and graphics, are merely a way of simulating the real world.

To begin, the Task Analyst (TA) applies his standard question.

"What is the context-view of the equipment which should confront the maintenance man first?"

enough of the motor to identify it as the motor (context) on a scale which will also allow the identification of the important element in the next step (focus).

The Task Analysis question that goes along with the first question is "What should be the focus of attention in the context view?"

The answer is that the focus should be the oil filter housing on the motor. The first and second questions on "context" and "focus" must always be asked in tandem. The result of the tandem questions in this case is requirements for a graphic scale that allows the "view" and "focus" elements to be recognized on the same gaphic by the man using the documentation. Further, the angle of view mus⁻ b⁻ the one that the user of the documentation will be using when approaching the equipment.

Now let us look at the graphic provided in the original documentation. How does it conform to the answers arrive at by the TA? First, the context view of the motor is of such a scale that the motor is easily recognized, but the oil filter housing is just a small blackened spot. The user of the documentation cannot see what the filter housing looks like. The original graphic shows the filter housing as a separate picture removed from the motor at the end of an arrow. The user does not see the filter housing in context on the motor, he sees it removed from the motor. It is shown disconnected with all oil lines disconnected, placed at the end of a broad arrow leading away from the motor.

The analyst then asks his third question, "What should the response action be?"

In the Engine Oil Filter task the answer is that the next step required is to remove the bolt from the bottom of the oil filter housing. Removing this bolt will allow the filter to be removed from the housing. When he then applies the "context-view" and "focus" questions, this time to the filter housing, he determines that the context view should be the housing with all oil lines attached. The angle of the housing should be such as to show the focus of the next step--the bolt on the underside of the housing.

Let us examine the graphic provided in the original JPA (Figure 1) to see if it provides this focus and context view.

No, the detached view of the filter housing is not at an angle to show the focus of the next step, the bolt. In fact, the bolt is shown on a graphic of the filter where the filter is already removed from the housing.

The TA once again applies the standard questions of "context-view", "focus" and "response action."

The context-view could be the housing or the filter depending on what response instructions were given in the previous step. If the TA merely told the user to remove the bolt, the filter would still be in place inside the housing. But if the TA combined removal of the bolt with removal of the filter in the previous step, the context-view would be the filter. How does the TA decide on whether to combine these steps or keep them separate? He must ask "What happens when the bolt is removed?" He gets the answer by removing it. In this case, the answer is that the filter comes out with it; in fact, he must be ready to catch it. Therefore, the two steps are combined, bolt removal and filter removal. So the new context-view is the filter that has just been removed from the housing by the previous response action.

The next response action is to place the removed filter in a special tool that looks similar to the housing the filter was removed from. This special tool must be shown as the focus in the context-view of the filter, and the response instructions must tell how to place the special tool over the filter. To this action the TA may decide to add the step of inserting the bolt that was removed previously to hold the filter in the special tool.

Let us look at the original graphic provided in the JPA. It shows the special tool (3), but it is not to scale. With the scale given it will not fit over the filter. Also the action given in the steps associated with the picture of the special tool is the removal of the bolt. That step should have gone with the previous context-view of the filter housing. We want the action of inserting the bolt in this picture of the special tool, not its removal. With this mix up in scale, graphic, and action the user

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FIGURE 1. SAMPLE JPA FRAME

CLEAN ENGINE OIL FILTER

WARNING

Do not allow oil to contact skin. If oil does contact skin, wash affected area with soap and warm water.

NOTE

If filter (1) is removed from aircraft, omit Task 1.

1. Place one-quart container under filter (1).

2. Cut and remove safetywire from bolt (5). Loosen bolt. Remove oil filter cover (4).

3. Install cleaning fixture (3) onto bolt (5). Tighten fixture. Install cap (2).

4. Immerse fixture (3) in dry cleaning solvent, P-D-680 (Type I). Periodically agitate fixture in solvent.

5. After all contaminants have been removed from cover (4), remove fixture (3) from solvent. Remove cap (2).

RỬA SẠCH BỘ LỌC NHỚT ĐỘNG CƠ

CỘI CHUNG

Đừng để nhớt dính lên da. Nếu nhớt dính lên da, rửa chỗ dính với xà phòng và nước nóng.

GHI CHÚ

Nếu đã tháo bộ lọc (1) khối phi cơ, bỏ mục Công tác 1.

1. Đặt lon một quart dưới bộ lọc (1).

2. Cắt và tháo dây kẽm an toàn khỏi bù-lon (5). Nới lỏng bù-lon. Tháo nắp của bộ lọc nhớt (4).

3. Gắn dụng cụ để rửa (3) vào bù lon (5). Siết dụng cụ. Gắn nắp (2).

4. Nhúng dụng cụ (3) vào dung môi rửa khô, P-D-680 (Loại I). Lắc từng hồi dụng cụ trong dung môi.

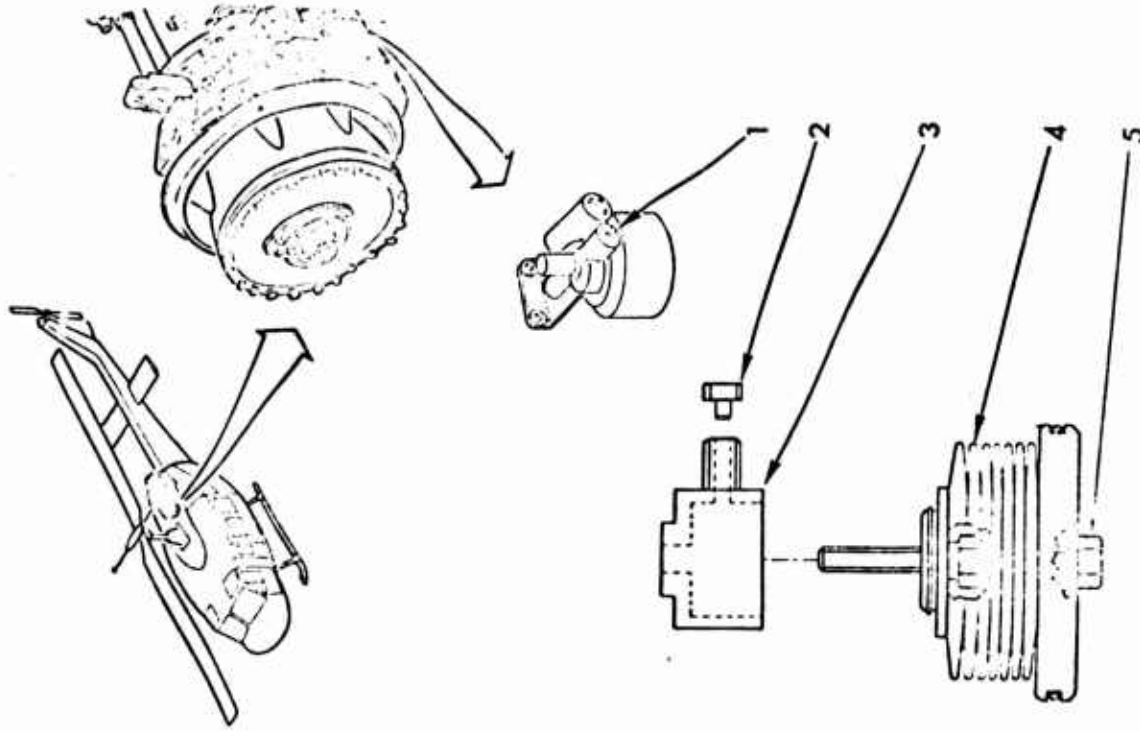5. Sau khi rửa sạch nắp (4), lấy dụng cụ (3) ra khỏi dung môi. Tháo nắp (2).

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must feel that he is "missing something." Therefore, he must interpret in order to do anything. An easy interpretation is that the special tool is the filter housing (they look similar); that the filter housing should be removed from the aircraft (the graphic shows it removed with all oil lines detached); and that the graphic showing the filter is irrelevant detail--including the one of the oil filter in the present graphic. It shows a cut-away view of the inside of the filter which is irrelevant. The user should regard this cut-away view as irrelevant. It is just as easy for the user to assume the entire view of what is inside the housing (the oil filter) is also irrelevant. This interpretation makes the user's actual responses much more understandable.

The TA determines that the next steps include a solvent bath, connection of an air hose to the special tool, blowing air through the filter, etc. The TA may find what next steps are required from inspecting technical data or from asking questions remembering that tech data is only a support to the TA, not the product.

There is no need to continue with what the TA does in this example. An important point to recognize in this review of the TA process is that all of the elements of technical data were represented in the original graphics. The JPA did not fail because tech data was missing.

The problem is that the equipment was not analyzed in the manner described in the example: i.e., by "context-view," "focus," and "response action" questions asked repeatedly and in concert while being performed on the equipment.

Once the TA of the equipment has been made it is easy to see what went wrong with the original version. But it would not be possible to find out what was wrong by an analysis of tech data items. Any specification which focuses on tech data to the detriment of Behavioral Task Analysis cannot accomplish what was done in this test.

It may be seen that the TA of this task did not merely result in corrections to the original version of the FP JPA. The entire fabric of the original instructions was wrong. There is not a single element of the

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original graphics which would be used in a final version even though all the elements were present in a "tech data" sense.

The conculsion to be drawn from this example is that the difference between a FP JPA that supports superior performance and one that does an inadequate job does not hinge on technical data, it hinges on perceptions and behaviors of the man who is the user. It might be said that we have known this for a long time. In fact, the simplified format of the FP JPA is one way of making it easier for the user; restricted verb list, no more than seven steps per page, graphics facing text, etc. These techniques certainly help in communication, but they are not sufficient. The missing ingredient is still the matching of perceptions and behaviors between the real equipment and the documentation which simulates it.